UNITED
NATIONS

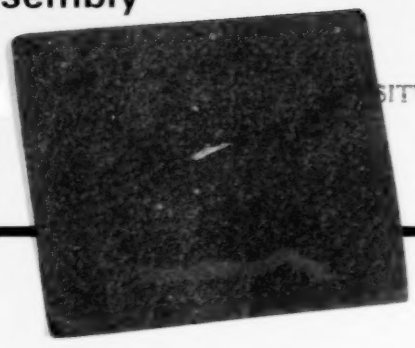
A

General Assembly

Distr.
GENERAL

A/AC.105/661/Add.1
23 January 1997

ENGLISH
ORIGINAL: FRENCH



COMMITTEE ON THE PEACEFUL
USES OF OUTER SPACE

# IMPLEMENTATION OF THE RECOMMENDATIONS OF THE SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

## International cooperation in the peaceful uses of outer space: activities of Member States

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V.97-20392T

## INTRODUCTION

1. In accordance with a recommendation of the Committee on the Peaceful Uses of Outer Space at its thirty-ninth session, Member States have submitted information on the following topics:[1]

(a) Those space activities that were or could be the subject of greater international cooperation, with particular emphasis on the needs of developing countries;

(b) Spin-off benefits of space activities.

2. The information on those topics submitted by Member States as of 30 November 1996 is contained in document A/AC.105/661.

3. The present document contains information on those topics submitted by Member States between 1 December 1996 and 22 January 1997.

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[1] *Official Records of the General Assembly, Fifty-first Session, Supplement No. 20* (A/51/20), para. 31.

## REPLIES RECEIVED FROM MEMBER STATES*

### Canada

[Original: English]

### *A. Canadian Space Program*

The activities the Canadian Space Program undertakes in human space flight, Earth observation, satellite communications, space science, and space technology development ensure that Canada makes an important contribution to the global space knowledge base and that space is used to generate socio-economic benefits for Canadians and humanity in general.

To accomplish these ends more effectively, the Canadian Agency (CSA) has undergone a process of reorganization and renewal. This has involved consulting extensively with all of the Agency's stakeholders, developing a new mission statement, completely reorganizing the Agency's corporate structure, and setting up a special task force to develop the Agency's Third Long-Term Space Plan.

### *B. Some of Canada's accomplishments in space in 1996*

#### *1. Earth observation*

Canada's first Earth observation satellite, RADARSAT, was launched on 4 November 1995, and became operational on 1 April 1996. Operated by the Canadian Space Agency, RADARSAT monitors the environment and supports natural resource management worldwide. Its data are received by the Canada Centre for Remote Sensing and are processed and distributed by RADARSAT International (RSI). The quality of the data is excellent and is exceeding specifications. Currently the system is generating approximately 2,000 scenes per month, a figure that will increase as network receiving stations come on line. To date, reception agreements have been completed with China, Norway, the United Kingdom of Great Britain and Northern Ireland and Singapore; many others are under negotiation. Preliminary work is also beginning on RADARSAT II, the follow-on satellite.

As just one example of its many uses, RADARSAT has proven very successful in the Canadian Arctic. Within four hours of reception at the ground station, data can be processed, interpreted, and diffused to users. Once provided to icebreakers of the Canadian Coast Guard and commercial ships, the images save costs for navigation and mapping, safeguard lives, and protect ships and equipment. Coverage of all ice-affected regions is routinely available every 1-3 days under all weather and light conditions.

One of the RADARSAT programmes that has proven enormously successful internationally is the Application Development and Research Opportunity Program (ADRO). The programme is jointly sponsored by the Governments of Canada and the United States of America and the licensed commercial distributor of RADARSAT data, RADARSAT International Inc. (RSI). The ADRO sponsors have sought proposals for two types of projects: those which exhibit innovative scientific research utilizing RADARSAT data; and those which demonstrate new RADARSAT applications for the development of products for specific applications. A few examples of the many projects that are currently under way: agriculture in Jordan and India; geology in Brazil and China; mapping in France and Chile; forestry in Indonesia and Finland; hydrology in Kenya and the Russian Federation; oceanography in Spain and Australia; archaeology in the United States; and sea ice in Japan and northern Canada.

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*The replies are reproduced in the form in which they were received.

Another RADARSAT programme worth noting is the RADARSAT User Development Program (RUDP), which supports the development by the Canadian value-added industry of RADARSAT applications. The response and support to RUDP has been very strong and has led to the development of RADARSAT applications for eastern Europe, Africa, and Asia.

An important event in the coming year will be a conference entitled Geomatics in the Era of RADARSAT (GER'97), 24-30 May 1997, at Ottawa. GER'97 will serve as the 9th International Geomatics Conference and will be the most important conference of the year for geomatics, particularly for radar remote sensing applications. Researchers from all over the world will present the results of their work and representatives from the geomatics industry will display their capabilities. The conference will encompass all aspects of geomatics including Geographic Information System (GIS), Global Positioning System (GPS) and remote sensing, from fundamental research to commercial applications. It will also cover policy, education and training issues. GER'97 is organized by the Canadian Aeronautics and Space Institute (CASI), the Canadian Space Agency (CSA), and the Canada Centre for Remote Sensing (CCRS), of Geomatics Canada, Natural Resources Canada.

### *2. Human space flight*

Also important this past year were the activities of three of Canada's astronauts. Bob Thirsk flew on STS-78, Life and Microgravity Sciences (LMS) Space Lab Mission. He and his six crew mates carried out 41 experiments to study the effects of gravity on the human body, on the development of plants and animals, on the processing of protein crystals and metallic alloys, and on fluid behaviour. Thirsk used the Canadian-developed Aquatic Research Facility to do experiments related to calcium development and behaviour in microgravity on several aquatic species at an early stage of development.

Marc Garneau, Canada's first astronaut in space, flew for a second Space Shuttle mission as a Mission Specialist aboard Endeavour, STS-77. Garneau carried out a series of international experiments, including four Canadian ones. The Commercial Float Zone Furnace, the prime payload for Mission STS-77, was a collaborative project between Canada, Germany and the United States to grow high-quality crystals using the Float Zone technique. The materials processed have tremendous commercial potential in the electronics and optical industries.

Upcoming Shuttle missions will involve Canadian astronauts Julie Payette and Steve MacLean as Mission Specialists and Bjarni Tryggvason and Dave Williams as Payload Specialists.

### *3. Space science*

In space science, 1996 saw the launch of the Canadian Ultra-Violet Auroral Imager (UVAI) instrument on board the Russian Federation's Interball mission in August from Plesetsk. This launch is the second in the Interball series of missions, following the Tail Probe mission launched in 1995. The UVAI camera has been developed to take snapshots of the auroral oval and thus provide greater insight into space weather phenomena.

In the context of global change, Canada is participating with Sweden, Finland and France on the Swedish-led ODIN satellite. Among other things, the Canadian contribution will include an Optical Spectrograph and Infra-Red Imaging System (OSIRIS) instrument. Launch is scheduled for November 1997 on a Russian Federation Start-1 vehicle.

Another major collaboration is with Japan on their PLANET-B mission to Mars. On this project, Canada will provide the Thermal Plasma Analyser (TPA), one of ten instruments on the spacecraft. The TPA will measure the local Martian thermal (cold, or lowest-energy) plasma density, drift velocity and temperature.

In space astronomy, Canada is collaborating on a joint programme, FUSE (Far Ultra-violet Spectroscopic Explorer), with the United States and France to create a space-borne astronomical spectroscope to observe the FUV wavelength region which contains a wealth of astrophysical information, yet is one of the least explored. Lyman FUSE will use high-resolution spectroscopy below the 1,200 Å HST (Hubble Space Telescope) limit to observe sources throughout our galaxy and at large extragalactic distances. This collaboration will allow Canada's astronomical community to share in the use of the facility.

In space life sciences, Canadian scientists participated with NASA and United States scientists on STS-77 and 78 with flights of the Canadian-developed Aquatic Research Facility and a Torso Rotation Experiment for the purpose of investigating the cause of motion sickness in astronauts. The CSA is also participating in space radiation experiments with the Russian Federation. For the future, two more flights of the Aquatic Research Facility for Canadian and United States scientists are scheduled for 1997 and 1998 and the CSA is participating with German and United States scientists on the NASA Neurolab spacelab scheduled for launch in 1998. The data being gathered will benefit astronauts and the health care sector; it will also help in the future development of global ecological models.

Canada also participated with the United States and the Russian Federation on Mir with the MIM (micro-gravity isolation mount) and QUELD, a furnace for performing liquid diffusion experiments.

### *4. International space station*

Work is continuing on the development of the Mobile Servicing System (MSS), Canada's contribution to the largest international science project in history, the International Space Station. The MSS is a sophisticated robotics system that will play a predominant role in the assembly, maintenance, and servicing of the Space Station, in which Canada is a partner with the United States, participating member States of the European Space Agency, Japan, and the Russian Federation. The flight SSRMS, the robotic manipulator, is undergoing the final system-level integration and tests and will be delivered in early 1997. The flight MBS, the mobile base, is being manufactured and assembled, and will be delivered in late 1997. The ground facility at the Canadian Space Agency, the MSS Operations Complex, became operational in November 1995 as the Space Operations Support Center (SOSC), and was used in a flight during and following mission STS-74. Work is continuing on the Canadian Space Vision System (CSVS) for the Space Shuttle and International Space Station.

### *5. David Florida Laboratory*

Finally, during 1996, the assembly, integration and environmental test facilities of the Canadian Space Agency's David Florida Laboratory were employed heavily by several different space programmes and projects. The major activities included the completion of a full environmental test campaign (thermal vacuum, vibration, RF, and mass properties measurements) on the Canadian MSAT M1 satellite (successfully launched on 20 April 1996), and the initiation of environmental testing on the various components (motor modules, joints, latching end effectors, and the mobile base system) for Canada's contribution to the international Space Station Project, the Mobile Servicing System.

## Important World Wide Web sites

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|---|---|
| Government of Canada | http://canada.gc.ca/ |
| Canadian Space Agency | http://www.space.gc.ca |
| Canada Centre for Remote Sensing | http://www.ccrs.nrcan.gc.ca/ccrs |
| Communications Research Centre | http://www.crc.doc.ca/crc/crchome.html |

## Greece

[Original: English]

### *A. Background*

Even though many Greek scientists, engineers and technicians have been involved in space sciences, technologies and applications from the very early space era, no global space policy and programmes were developed until the end of the 1980s.

On the other hand, several Greek universities, scientific research institutions and public entities, including the Hellenic Telecommunications Organisation (OTE), had successfully undertaken important individual space activities in various scientific as well as operational areas.

In 1981 Greece became a member of the Committee on the Peaceful Uses of Outer Space (COPUOS) and shared this post on a three-year rotation basis with Turkey until 1994, when it became a permanent member. During this 15-year period Greece did not fail to positively contribute to COPUOS activities. The most important of its contributions was the Greek initiative for the establishment of a regional network of space science and technology education institutions for central-eastern and south-eastern Europe.

In 1991 the Greek Government, in view of the very important impact of space activities on national life not only from the scientific and technical, but also from the political, defence, economic, social and cultural point of view, and in order to coordinate all respective national efforts in this sector, established the National Space Committee as a consultative body to the Ministry of Industry, Energy and Technology (now Ministry of Development), which was reorganized in 1994 and renamed the "Hellenic Space Research and Technology Committee" (HSRTC).

The two most significant recent acts of HSRTC have been the conclusion in 1994 of a Cooperating Agreement between Greece and the European Space Agency (ESA), on the one hand, and the study for a national space policy plan, on the other.

### *B. Areas of space activities*

Greek public agencies and academic and other scientific research institutions are involved in the following main areas of space activities.

#### *1. Geodesy and geodynamics*

*National Technical University of Athens*

Since 1965 operates at Dionyssos (northern suburb of Athens) a Satellite Observatory, which is equipped with a Bakker-Nunn camera, laser ranging, Doppler system, GPS and Doris system, and focuses on applications within the fields of geodesy and geodynamics.

*Aristotelian University of Thessaloniki*

Similar satellite-based GPS activity, which emphasizes the seismological investigation of central and northern Greece.

Both above-mentioned universities are also involved in research work on precise orbit determination using laser-ranging and satellite altimeter data, which are also used to determine the mean sea level, as well as the ocean variations on a global scale.

*2. Earth observation*

Considerable activity was developed in Greece concerning Earth observation, in vastly different application areas such as meteorology, climatology, upper air studies, land cover/land use, forest mapping, cadastral mapping, marine research etc. More specifically, these activities mainly include meteorological satellite receiving stations and Earth-observation user communities.

*(a) Meteorological satellite receiving stations*

*National Meteorological Service*

Has developed the Project PROTEAS (Primary Research and Operations Tele-detection Environmental Archiving System), which consists of a primary data user station for Meteosat, a high resolution picture transmission (HRPT) for the National Ocean and Atmospheric Administration (NOAA) and a meteorological data-distribution receiving station. It is complemented with a network for the dissemination of meteorological images and products to interested parties.

PROTEAS will enhance satellite-related research in Greece, and it is expected that several public agencies dealing with the environment, energy, technology, national economy, planning, agriculture, shipping, public works etc. will use its products.

*Ionospheric Institute, National Observatory of Athens*

Operates a third NOAA HRPT station, which complements NATO's SFS Programme "Thalases".

*Laboratory of Agro-Meteorology, University of Thessalia*

Operates a NOAA HRPT station and a Meteosat-PDUS station, the main uses of which are extended to the fields of physical environmental dangers and agrometeorology.

*(b) Earth observation user communities*

Remote sensing applications are utilized in numerous Greek public agencies and academic and other scientific research institutions, which are involved more specifically in meteorology, climatology and atmospheric sciences, as well as in other similar areas of Earth observation. Most of them also offer education and training in this field.

*(i) Meteorology, climatology and atmospheric sciences*

Greece is a member of Meteosat and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) and participates in all their committees and scientific and technical activities, such as the current Meteosat Operational Programme (MOP).

In the country, emphasis is given to the study - by means of satellite data - of the atmospheric phenomena that influence diffusion and dispersion patterns in the lower atmosphere, as well as in the definition of the concentrations of chemical species in the upper troposphere and in the stratosphere.

All the above-mentioned studies are performed by the following institutions.

*National Centre for Space Applications*

Undertakes comprehensive remote sensing activities. It also represents the Greek Government in both the Scientific and Technical Subcommittee of COPUOS and the Western European Union (WEU) Space Group, and assumes the responsibility of the national cell between Greece and the WEU Satellite Centre.

*National Meteorological Service*

Has the overall responsibility of meteorological issues in Greece, including the representation of the country in the respective international organizations. It operates a wide number of meteorological stations, dispersed throughout the Greek territory and connected to the Central Meteorological Office in Athens via a telecommunication network.

*Institute of Meteorology and Physics of the Atmospheric Environment, National Observatory of Athens*

Performs regular meteorological and solar energy observations. It also runs specific projects related to: the use of infrared imagery for public agencies, academic and other research institutions; thermal loss in urban areas; and the use of NOAA satellite images for the operational definition of cloud systems.

*Laboratory of Meteorology, National University of Athens*

Pursues research in satellite meteorology, air quality, stratospheric and tropospheric ozone, energy budget, cloud analysis and motion patterns of air masses. It participates in several international campaigns for the study of the ozone concentration. It also operates - for educational purposes - a secondary satellite station for low resolution images from Meteosat and NOAA satellites. Special emphasis is given in the use of satellite data for the definition of the chemical structure of the troposphere and stratosphere in the south-eastern Mediterranean and for the operational monitoring of the distribution of aerosols in urban areas.

*Aristotelian University of Thessaloniki*

Ground-based measurements, as well as satellite data, are used periodically for the production - in the framework of a United Nations programme - of global ozone maps.

*(ii) Other activities in the fields of Earth observation*

*Ministry of Agriculture*

Runs two nationwide projects in the field of remote sensing. The first, concerned with agricultural statistics, started in 1991. Approximately 100,000 hectares are studied every year. The second aims to ameliorate the effective control of the accuracy of declarations of Greek farmers subsidized by the European Union.

*Ionospheric and Space Research Institute*

The institute has developed a remote sensing laboratory, with full digital image processing facilities. Additional database management, image processing and GIS facilities are installed in its premises. These facilities, which belong to the Hellenic Space Research and Technology Committee are funded by the Greek Operational Programme for Research and Technology of the Ministry of Development.

*Hellenic Mapping and Cadastral Organisation*

Produces land cover maps of Greek territory in the framework of the CORINE Land Cover EU Programme of the European Union. It is also responsible for the Cadastral Programme.

*Institute of Geology and Mineral Exploration*

Uses remote sensing techniques and data in geology, hydrogeology and tectonics. Landsat and SPOT images and aerial photography are used. One of its special projects is concerned with the investigation of the structural control of mineralization in the eastern Rhodope region of north-eastern Greece.

*National Foundation for Agricultural Research*

Applies remote sensing techniques to monitor agricultural lands and produce land use and soil taxonomy maps.

*National Centre for Marine Research*

Uses NOAA-AVHRR (Advanced Very High Resolution Radar) and Nimbus-7 CZCS data to study the temperature profiles and chlorophyll contents of the sea surface layer. It also uses Landsat data for offshore studies and *in situ* ship measurements.

*Remote sensing laboratories*

Department of Geology, National University of Athens

Conducts land use, mapping and geological studies. It has also participated in the European Union programme entitled "Remote sensing in the management of less-favoured areas".

Department of Topography, National Technical University of Athens

Develops integrated remote sensing and GIS methods and techniques for the prevention of desertification and the detection of illegal housing after forest fires, agricultural land-use mapping, the study of coastal zones etc.

Aristotelian University of Thessaloniki

Specialized in forestry, agriculture and geology, produces thematic geological and agricultural maps by using Landsat and SPOT images. In addition, the Laboratory of Agriculture applies remote sensing techniques for the management of less-favoured areas in the framework of the relevant European Union programme.

University of Aegean

Uses satellite images from NOAA, Landsat and SPOT satellites in order to update medium-scale maps, monitor the oceanic environment and assess forest conditions.

Demokretian University of Thrace

Applies remote sensing for both land and ocean applications. It also participates in manufacturing for space applications.

Finally, a number of activities in Earth observation, both at the national and European Union levels, are currently in process in Greece. Emphasis is given to the Centres for Earth Observation (CEOs), which belong to the joint European Union and ESA programme for the development of a decentralized network, and the European Earth Observation System (EOOS) aimed at the enhancement of the value and usefulness of data. CEOs will contribute to EOOS operation by providing user-oriented services. For Greece, EOOS offers a considerable framework for the development of Earth observation activities not only locally, but also in the wider Balkan and eastern Europe area.

*(iii) Education and training in Earth observation*

Greece, in accordance with the UNISPACE II recommendations, developed various educational programmes covering several space applications many years ago.

Syllabuses of several Universities in Greece include undergraduate and postgraduate study programmes in Earth Observation (principles, technology etc.) and its applications.

Furthermore, the National University of Athens, the National Technical University of Athens, the Aristotelian University of Thessaloniki, the National Observatory of Athens, the Greek Productivity Centre, the Evgenidis Foundation (Planetarium of Athens) and other similar institutions provide postgraduate continuing education and training programmes in Earth Observation in the framework of the European Social Fund and the COMETT Programme.

*3. Space telecommunications*

Since 1992 a very large development programme concerning the modernization and re-regulation of the telecommunications sector in Greece is under evolution with the strong financial and technical support of the European Commission.

A feasibility study concerning the creation of a national satellite communications system, the Hellas-Sat, has already been completed.

On the other hand, OTE, the Greek public operator, is the only signatory from the part of Greece in INTELSAT, Inmarsat and EUTELSAT systems.

OTE participates in INTELSAT via five operational Earth stations installed in two Satellite Communication Centres located at Thermopylae (central Greece) and Nemea (northern Peloponessus). About 40 satellite links (corresponding to more than 1,000 terrestrial circuits) are currently established via the said Earth stations. TV facilities are also offered.

Also, OTE is the fifth largest shareholder of Inmarsat (5.41 per cent of investment shares). The Thermopylae Land Earth Station (LES) operating with Indian Ocean Region Satellite provides maritime and land mobile satellite services through Inmarsat-A and Inmarsat-C since 1985 and 1993 respectively. About 1,100 Inmarsat terminals of all types are today in operation on Greek-registered ships. The total traffic served by Thermopylae LES during 1995 was approximately 4 per cent of the global annual Inmarsat traffic. A new LES located again at Thermopylae, operating now with the East-Atlantic Ocean Region Satellite, will offer Inmarsat-A and Inmarsat-C services in early 1997, while Inmarsat-M/B and Mini-M services are scheduled for mid-1997 in both LES.

EUTELSAT satellites are used by OTE and other enterprises in Greece mainly for TV and business services. Three TV standard Earth stations, installed in Athens and Thermopylae, offer direct-to-home, point-to-multipoint and occasional TV services. One standard satellite multi-service (SMS) station, installed in Athens, offers videoconference and data services. There are also about 30 registered SMS/VSAT very

small aperture stations for data services, and about 100,000 receive only TV terminals in customer premises in various places in Greece.

Finally, OTE offers training courses for ground-station engineers and technicians.

## Republic of Korea

[Original: English]

Space activities in the Republic of Korea originally started with scientific purposes in mind. A series of small scientific satellites, the KITSAT series, and sounding rockets KSR pioneered Republic of Korean space development. Recently the Republic of Korea has seen major advances in its space programme with the launch of KOREASAT-1 and KOREASAT-2, enabling it to use space commercially. As a continuing effort, two-stage KSR and KOMPSAT are under development for launch in 1997 and 1999 respectively.

### *A. Summary of space activities*

KITSAT 1 was launched on 10 August 1992 by Ariane flight V52 and placed into a 1,301 x 1,402 km orbit with a 66.1 degree inclination. The satellite has a mass of 50 kg, is box-shaped with the dimensions 35 cm x 35 cm x 67 cm and as payload carries:

- PACSAT Communication store-and-forward communications system (13 Mb RAM, 9.6 kbits/s downlink)
- EIS Earth Imaging System (two cameras: 2-3 km and 400 m resolution)
- DSPE (Digital Signal Processing Experiment)
- CRE (Cosmic Ray Experiment) particle radiation detector.

KITSAT 2 was launched on 26 September 1993 by Ariane and placed into a 795 x 805 km low Earth orbit with a 98.68 degree inclination. The satellite is box-shaped with the dimensions 35 cm x 35 cm x 67 cm, has a mass of 47.5 kg and as payload carries:

- Earth Imager, DSPE (Digital Signal Processing Experiment)
- IREX (infrared detector experiment)
- LEED (low energy electron detector).

KOREASAT-1 was launched on 5 August 1995 by a United States of America Delta launch vehicle and placed into a geostationary orbit at a latitude of 116 degrees East. The satellite is box-shaped with the dimensions 163 cm x 132 cm x 99 cm with solar arrays spanning 15.45 m and a reflector with a diameter of 1.52 m x 1.83 m. It had a mass of 1,459 kg at launch and carried a payload of transponders for domestic communications, very small aperture terminals (VSAT), data, video and Direct Broadcasting Systems (DBS).

KOREASAT-2 was launched in January 1996 by a United States Delta launch vehicle and placed into a geostationary orbit at a latitude of 116 degrees East. The satellite has the same configurations as KOREASAT-1, and also carries the same payload.

KOMPSAT (Korea Multi-Purpose Satellite) is planned for launch in 1999 and will be placed in a sun-synchronous orbit, at an inclination of 98 degrees. The satellite is 1.8 m in height and has a diameter of 1.1. m. It has a total mass of 500 kg and as payload will carry a high resolution CCD camera; a low resolution camera (Ocean colour monitor); a high energy particle detector; and an ionospheric measurement sensor.

In addition to the satellite programme, the Republic of Korea has an active sounding rocket programme. The KSR series rockets have a mass of 1.2 tonnes and are 42 cm in diameter and 6.7 m in length. They are unguided and use solid-propellant motors. The payloads are ozone measurement sensors. To date, two rockets have been launched, KSR-1 on 4 June 1993, with an apogee of 39 km, and KSR-2 on 1 September 1993, with an apogee of 49 km. A two-stage KSR, planned for launch in 1997, will have an apogee of 150 km. This 2-tonne rocket will be 42 cm in diameter, 11 meter in length and will be canard-fin-controlled. It will have an ionospheric measurement sensor, ozone measurement sensor and X-ray detector as payload.

Currently the domestic space industry of the Republic of Korea is still in its infancy. However, it has good potential and will soon catch up with the leading group in the near future. Major companies participated in the development and manufacture of subsystems for the KOMPSAT programme. Some companies such as Hyuandai Electronics Inc., Korea Telecom, and Dacom, Inc. are also participating in the international consortium of communication satellite projects such as Iridium and Globalstar.

The Republic of Korea has prepared a long-term national space development plan toward 2015. Under this long-term plan, detailed action programmes are in preparation. The detailed programmes will be pursued vigorously by industry, academia and in government, thus helping the Republic of Korea enter into the advanced group in the space industry in the next century.

## Switzerland

[Original: French]

Since Switzerland does not have a national space agency, it does not operate any national space programmes as such. Space activities are conducted through its participation in the European Space Agency, where, in addition to the mandatory activities (including the general budget and science programme), it is involved in the programmes relating to launch vehicles, Earth observation, manned space flights, telecommunications, microgravity and technology, and also PRODEX (scientific experiment development programme supporting university groups and promoting cooperation between university institutes and industry).

## United Arab Emirates

[Original: English]

The development of new or improved materials has constantly been a decisive element of technological progress throughout human history. Today, there is an increasing and stringent demand for materials specifically adapted and tailored for a particular application in virtually all disciplines, from metallurgy to electronics. Progress in materials science has become one of the most powerful weapons in worldwide industrial competitiveness.

The growth of single crystals from a mother fluid phase, either liquid or vapour, involves nucleation and growth processes. Growth per se involves interface phenomena, bound to mass and heat transport through large distances in the adjacent mother phase. In the crystallization process, the interface acts as a local heat source due to the release of the latent heat of solidification, and as a source or sink of solute according to the solute thermodynamical segregation coefficient. Two mechanisms may be responsible for the transport of species: diffusion and convection.

The crystal growth research presents great interest, since it virtually covers all the so-called functional materials which are the trunk of strategic and highly competing industries such as electronics and telecommunications. Those industries bring into play the most advanced technologies in order to master the properties of materials at the microscopic and, in some cases, at the atomic scale. This implies, in particular, very elaborate growth techniques and optimized growth conditions.

Single crystals of BGO($Bi_{12}GeO_{20}$), BSO($Bi_{12}SiO_{20}$) and their solid solutions are wide band-gap, high resistivity semi-insulators that are also piezoelectric, photoconductive, acousto-optic, magneto-optic and optically active. As such, they have found widespread applications in optical information processing and computer components such as spatial light modulators and photoreactive volume holographic optical elements. Bismuth silicate (BSO), Bismuth germanite (BGO) and their solid solutions have created a great deal of interest in the forms of bulk crystals and epitaxial films for opto- and acousto-electronic applications in integrated devices. These materials and their solid solutions in single-crystal form can be used as substrates for thin-film epitaxy devices for optoelectronic applications in integrated optics.

Gallium Arsenide (GaAs) is one of the important semiconductor materials for the production of optoelectronic devices, and is largely required by the computer, telecommunication and electronic industries. It processes the properties desirable for high-speed signal processing and light-emitting devices.

The goal of present research is to study the float zone growth process of binary and tertiary semiconductor materials. Three different projects are under way in the Department of Mechanical Engineering of the United Arab Emirates University.